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ABSTRACT

This booklet provides methods that teachers can use to analyze questioning techniques and suggests ways that teachers can develop variety in the type of questions they ask. Both Bloom's "Taxonomy of Educational Objectives, Handbook I: Cognitive Domain," and the Question Category System for Science are discussed as systems for classifying questions. Suggestions are given for recognizing question types and for devising open questions to use in the classroom. The importance of pausing for a sufficient amount of time between questions is also discussed. A selected bibliography is included. (MH)

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NATIONAL SCIENCE TEACHERS ASSOCIATION

INSTRUCTIONAL AID

how to...

ASK THE RIGHT QUESTIONS

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INTRODUCTION

"Who can briefly review what we did yesterday?" "What's the chemical formula for ethyl alcohol?" "Why don't you pay attention?!" "What do you think would happen if . . .?" "What's the name of the planet closest to the Sun?" "Do you think anything else might have influenced your results?" "Who has another opinion on this?" "Where's your homework?" "Are you ready to begin timing?" "Can you design an experiment to test the hypothesis?" "What's chlorophyll?" "How do you know that's granite and not gneiss?" "If that's the genotype what would the phenotype be?" "Can you all follow that?" "Where do you think you're going?!" "What's the answer to question 5?"

Questions, questions, questions! They seem to be a large part of a teacher's stock in trade. We use questions to help students review, to check on comprehension, to stimulate critical thinking, to encourage creativity, to emphasize a point, to control classroom activities and cut down on disruptive behavior, to help us determine grades, to encourage discussion, to discourage inattentiveness, and for many other reasons and purposes. Questioning style, and content, varies from teacher to teacher, student group to student group and situation to situation.

To help you focus on this common teaching activity, the asking of questions, is the purpose of this "How to . . ." booklet.

As teachers we sometimes get so involved in asking questions that we don't give much time to analyzing why and how we do it. Questioning seems such a natural technique that we don't give it much thought.

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If we were to analyze the questions we ask during a class period, we might be surprised. However, we would probably discover that most of the questions were designed to determine whether a student does, or does not, know a particular item of information.

The curriculum improvement projects in science (and in other subjects) of the last several decades contain much emphasis on using teaching techniques that promote the discovery of information *by* students, not the transfer of information from teacher *to* students. If we as science teachers wish to encourage "learning by discovery" or student inquiry, we need to learn to ask questions which stimulate students and encourage them to think. We still need, at times, to check for the correct recall of basic items of information, but this should be only one of the reasons for asking questions, not the primary reason.

The remainder of this booklet is devoted to providing some methods which you can use to analyze your questioning strategy and to suggest some methods for developing variety in the kinds of questions you ask.

TYPES OF QUESTIONS

To develop variety in questioning, you need to know what kind of questions you commonly ask. Research on the questions teachers ask shows that about 60 percent require only recall of facts, 20 percent require students to think, and 20 percent are procedural in nature (Gall, 1971). By analyzing your questioning behavior you may be able to decrease the percentage of recall questions and increase the percent of questions that require students to think.

There are numerous systems for classifying questions. Some are listed at the end of this booklet. Many of these systems are based on the seven categories listed in Bloom's *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain* (1956). Norris Sanders, who developed a classification system for use with social studies materials, used Bloom's taxonomy to place questions in one of seven categories: (1) memory (recall); (2) translation (changing information into different symbolic form or language); (3) interpretation (seeing relationships); (4) application (solving a life-like problem by drawing on generalizations and skills); (5) analysis (solving a problem from conscious knowledge of the parts and forms of thinking); (6) synthesis (solving a problem requiring original creative thinking); and (7) evaluation (making judgments according to standards) (Sanders, 1966, p. 3).

There are other classification systems based on Bloom's taxonomy. For example, Clegg (also working in social studies) developed a six level question category consisting of memory, comprehension, application, analysis, synthesis, and evaluation (Clegg, 1967).

In even less-complicated systems questions are classified as relating to *knowledge* or *higher*, (meaning, one or more of the other six categories in Bloom's *Taxonomy*) but this may be an over-simplification. It does help determine whether you are emphasizing factual recall in your questions, but it does *not* help you decide what you are emphasizing above the thinking level of the factual recall of knowledge.

The Question Category System for Science (QCSS) consists of three levels of classification, two of which will be described in this booklet. You can first classify your questions as being one of four major types: Closed, Open, Managerial, or Rhetorical (Blosser, 1973).

Managerial Questions are those used by the teacher to keep the classroom operating, to move activities (and pupils) toward the desired goals for the period or lesson or unit. Such questions as "Does everyone have the necessary equipment?" "Will you turn to page 15, please?" or "Who needs more time to finish the experiment?" are classified as belonging to this category.

Figure 1. *Major types of Questions Teachers Ask (QCSS)*

Question Type	*Question Function*
Managerial	To keep the classroom operations moving
Rhetorical	To emphasize a point, to reinforce an idea or statement
Closed	To check the retention of previously learned information, to focus thinking on a particular point or commonly-held set of ideas
Open	To promote discussion or student interaction; to stimulate student thinking; to allow freedom to hypothesize, speculate, share ideas about possible activities, etc.

Rhetorical Questions are used by teachers to reinforce a point or for emphasis. "The green coloring matter in plants is called chlorophyll, right?" or "Yesterday we said there are three major groups of rocks: igneous, sedimentary, and metamorphic, okay?" fit into this category. Teachers asking rhetorical questions do not really anticipate receiving an oral student response, although they sometimes get one.

Closed Questions are those for which there is a limited number of acceptable responses or "right answers." "What is the chemical formula for water?" "What happened when you switched from low to higher power magnification?" or "What are plant cell walls made of?" are questions which anticipate certain answers. It is expected that students have already had contact with the information requested from a teacher lecture, class activity, assigned reading, or some visual aid (film, filmstrip, chart, demonstration).

Open Questions anticipate a wide range of acceptable responses rather than one or two "right answers." They draw on the student's past experiences but they also cause students to give opinions and their reasons for these opinions, to infer or to identify implications, to formulate hypotheses, or to make judgments based on their own values and standards.

Examples of Open Questions might include "If you were to design a science display for the school bulletin board, what would you include in the display and why?" "What do you suppose life on earth might be like with weaker gravity?" "What should be included in a project to improve the school environment?" or "If you suspected that you were the carrier of some genetic abnormality, would you have children?"

If you want to get a little more sophisticated in classifying your questions, the *Closed Questions* and *Open Questions* categories can be further subdivided into the types of thinking implied or expected. (See Figure 2.)

Closed Questions need not always be of the factual recall type in which students are expected to orally fill in the blanks or respond with one or two word answers. They also include those which are designed to cause students to classify or pick out similarities and differences, to apply previously learned information to a new problem, or to make a judgment using standards which have been supplied. Both levels of thinking are important for students, but it is also important that your questioning activities do not stay entirely within the *Closed Question* areas.

Figure 2. *Levels of Thinking Implied by Questions*

Question Type	*Level of Thinking Expected*
Closed Questions	Cognitive-Memory Operations
	Convergent Thinking Operations
Open Questions	Divergent Thinking Operations
	Evaluative Thinking Operations

(Adapted from Blosser, 1973, p. 10)

WHY ASK A VARIETY OF QUESTIONS?

If one of your objectives as a science teacher is to produce students who will be responsible citizens and use the knowledge and skills from science classes in real life problem solving, you will want to ask a variety of questions. Stressing only *Closed Questions* encourages students to become skillful in the stockpiling and retrieval of data. While certain items of information are more conveniently memorized and recalled than repeatedly looked up, the ability to memorize information and recall it should not be the only–nor the most important–objective of science teaching.

Events and discoveries in science occur all the time and at a rapid pace. Older ideas must often be reinterpreted, or abandoned. It is unrealistic to assume that you can help your students to acquire all of the scientific knowledge they will ever need to know. It is more important to provide experiences that help students develop the skills of acquiring and processing data into useful information. *Open Questions* can be used to help students develop these skills.

HOW CAN YOU RECOGNIZE QUESTION TYPES?

You can determine what types of questions you use most frequently by analyzing the number of acceptable responses which are possible. You should also ask yourself whether the question encourages, or even requires, your students to go beyond past information in formulating a response.

A third technique is to analyze key words or phrases in the question. Terms such as *who, what, when, where, name,* and sometimes *how* and *why* are frequent signs of *Closed Questions* (Blosser, 1973). Words such as *discuss, interpret, explain, evaluate, compare, if,* or *what if* (Groisser, 1964) may call for more than the retrieval of memorized information.

One word of caution. Teachers sometimes think that if they begin a question with *why* or *explain* or *compare* or *interpret* they are automatically encouraging their students to perform divergent or evaluative thinking operations. They may be, but they may also only be requiring cognitive-memory operations if (a) their question focuses on information available from a previous lesson or experience or (b) their question relates to information the student has already acquired from some previous class or experience. You can only guard against the possibility described in alternative (b) by knowing all of the science-related interests and activities of your students. The point is to guard against a belief in magic questioning words which will assure more than cognitive-memory thinking by your students.

Nevertheless, the wording of questions *is* important. Many times teachers have an excellent idea for a question but fail to stimulate thinking by failing to consider how the

question is going to sound to the student. Some questions are too vague—"What about Pasteur?" Some questions are so lengthy that the student gets bogged down in trying to keep the parts separated as the teacher asks the question. If you find yourself formulating a long, involved question, try changing it into a series of related questions.

MATERIALS, ACTIVITIES FOR OPEN QUESTIONS

Some materials and topics are better sources of *Open Questions* than others. Newspaper and magazine articles, pictures, displays (on the bulletin board, in a display case, in a science corner, or on the demonstration desk), and short science-related problem situations are often useful sources. A discrepant event (a situation which presents an inconsistency between what people commonly believe should happen and what does happen) [the Suchman Inquiry Program films provide examples] also may become the focus of some *Open Questions*. There are additional suggestions in the references listed at the end of this booklet.

Don't overlook appropriate times for varying your questions when using activities and introducing new topics. Using *Open Questions* before beginning a topic or unit can help you learn about your pupils' backgrounds in this area as well as help you stimulate their interest in the material to be studied. Using *Open Questions*, particularly those designed to stimulate divergent thinking, can help you and your class decide on things to investigate, additional activities to consider, and related areas to explore either as individuals, in small groups, or as a total group.

While your students are involved in laboratory activities and investigations, you can circulate among them and use different types of questions. *Open Questions* can be used to challenge the more able students to consider alternative ways of interpreting data or additional hypotheses to form and test. *Closed Questions* can be asked of the less able or less interested students to help them determine if they understand what is involved in the activity.

When the activity has been completed and your class reassembles, either as a total group or in small groups, asking a variety of questions is again important. *Closed Questions* can be used to determine the extent of agreement or disagreement among people who supposedly worked on the same activity (Thier, p. 149). *Open Questions* can be asked toward the close of the discussion to stimulate further investigation as well as to set the stage for activities to follow.

THE VALUE OF SILENCE

What you say and how you say it are both important factors to keep in mind in improving your questioning behavior. It is equally important to learn how and when to *remain silent.*

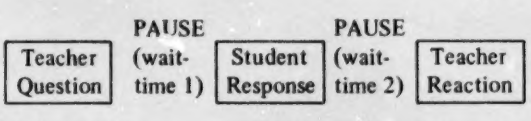
A common finding of investigations of teacher behavior and verbal communication in classrooms is that teachers do most of the talking.

In attempting to improve your questioning behavior by concentrating less on questions that stimulate only factual recall (cognitive-memory thinking) and more on developing *Open Questions*, you have also obligated yourself to provide your students with the opportunity to do two things: (1) to have enough time to think and formulate an adequate response to your questions and (2) to have the time to share this response with their classmates as well as with you, their teacher.

This means that you consciously need to learn to pause (Far West Laboratory, 1968; Blosser, 1973) or to build in "wait time" (Rowe, 1973). How long should you pause or wait? Suggestions range from 3 to 5 seconds.

Rowe, who has worked extensively with teachers and children using some of the elementary school science curriculum project materials, writes of an additional time when the teacher should pause (1974, p. 265). This pause, which she calls wait-time 2, occurs *after* the student has responded to the teacher's question (wait-time 1, occurs when the teacher pauses after asking the question) but *before* the teacher reacts to the student's response.

Figure 3. *Times When It is Important to Pause*



Pausing after asking a question (wait-time 1) provides your pupils with the opportunity to consider your question and formulate their responses. Including wait-time 2 in your questioning technique provides your students with the opportunity to add to, modify, or elaborate on the response they have just given.

Rowe and others who have investigated questioning have found that when teachers learn to pause or increase their wait-time (particularly wait-time 1), some of the situations listed below begin to occur:

1) The length and number of students' responses increases
2) "I don't know" and failures to answer decrease
3) the incidence of speculative thinking increases
4) more evidence, followed by or preceded by inference, is expressed
5) the number of questions asked by children increases, and the number of experiments they propose increases
6) contributions from "slow" students increase (Rowe, 1973, p. 343).

ADDITIONAL FACTORS RELATED TO QUESTIONING

By now you are probably wondering if there are strategies to be considered in analyzing your questioning behavior in addition to those of varying the questions and learning to remain silent. Yes, there are.

Some of these are implicit in one of the chapter titles in Rowe's methods book. Chapter 11 is called "Inquisition Versus Inquiry." Rowe differentiates between these by saying, "... Inquiry is something teachers and students may do together. Inquisition is something teachers do to students." (1973, p. 333).

What does this mean? Well, for one thing, it means that you are going to use questions to help students learn to investigate for themselves rather than using questions to determine if the students have been properly indoctrinated with facts.

For another thing, it means that you need to decrease the number of questions you ask during a lesson. Don't fall into the trap of thinking "the more questions, the better the teaching." By learning to ask *Open Questions* which are designed to stimulate thinking and consequently produce longer student responses and by learning to pause at the appropriate times, you will find that the pace of the lesson slows down.

This change of pace also implies another factor: you probably will cover less material. What you and your students do discuss, however, will probably be in more depth. You may find your students bringing into the discussion related ideas that you had not foreseen when you preplanned the lesson.

Any additional considerations? Yes, indeed. It is unrealistic to think you are going to successfully use *Open Questions*, even when you have learned to formulate them and have appropriate materials and activities, if you do not have a classroom atmosphere that is conducive to your students sharing ideas and opinions.

Students are not likely to volunteer very much if they feel unsafe or inadequate. As teacher you have to make certain that your students' responses are accepted and that the students themselves are respected as individuals. Students experience verbal (and nonverbal) put-downs if their classmates mutter "Dummy!" or "What do *you* know?". They are not likely to continue to participate when their contributions meet with rejection. This does not mean that students should never be told that their responses are incorrect or inadequate. Such feedback must be skillfully phrased to encourage them to think again and modify their responses.

In addition, you as teacher need to refrain from always providing an authoritative answer to every question. Your students need to learn to live with uncertainty as they inquire and explore.

Sometimes teachers inadvertantly provide answers as they attempt to reinforce their students. They do not mean to set themselves up as the final authority, but in reinforcing responses they create a dependency in their students to look to the teacher for the final determination of the adequacy or correctness of a response.

Rowe discovered that when teachers had a high rate of reinforcement of student responses, their students did not engage in as much exploration and inquiry as anticipated (1974, p. 293). Considering the teacher and student behavior observed and recorded, Rowe concluded that rewarding or "sanctioning" (as she calls it) might be undermining confidence and causing students not to feel safe to explore.

Rowe also speculated that high rates of reinforcement by teachers might discourage the sharing of ideas since one student might get praised for an idea first developed by another student (1974, p. 294).

Room arrangements sometimes hinder student interaction and discussion if fixed desks or tables cause students to have to talk to the backs of each other's heads. You are the best judge of how you might modify seating arrangements when you want to have either small group or total class discussions. Another more subtle factor related to discussions is your physical position during the discussion. If you really want the interaction to flow freely, try taking a position that puts you on the same plane as your students. When you stand or sit above them, you signify your role as final authority and they tend to look at you even when addressing their remarks to a classmate.

A final and most important factor relates to your personal philosophy of education and to your perception of your role as teacher. If you consider your major responsibility to be that of the transmission of a body of knowledge, you have probably found much to argue with in the material you have just read. One of your primary objectives probably is that of exposing your students to as much of the large amount of accumulated information of science as they can comprehend at their given level of intellectual development. Most of the questions you ask to determine how well you are achieving this objective are of the *Closed Question* types and probably the majority of those question stress cognitive-memory thinking.

However, if you feel that one of your most important contributions to your students is that of providing them with the opportunity to learn to use the process skills (observation, classification, measurement, hypothesizing, etc.) and to learn to investigate, to identify problems and invent methods for possible solutions, you have probably discovered, in reviewing the methods you use in teaching and questioning, that you already are practicing many of the behaviors described.

No teacher operates all the time either as dispenser of information or guide to learning. But, are you aware of which role you tend to assume most of the time in your teaching?

ANALYZING YOUR QUESTIONING BEHAVIOR

What are some ways to determine how you function, particularly in your question-asking? One thing you can do is to jot down the questions you plan to ask during a particular lesson. (You may already be in the habit of doing this.) Once these are written down, check them for the level of thinking they are intended to stimulate. Do this from time to time and from topic to topic (or activity) since some topics and activities are more productive of variety in questioning than are others.

An additional method of providing yourself with information about your verbal behavior during a lesson is to tape record it. Some people hesitate to do this because they feel their students will not respond in their usual manner if they are aware of the lesson is being recorded. If you share this concern, you can attempt to disguise the recorder (but students are perceptive and inquisitive). It is also possible to use it so frequently that it becomes just another piece of equipment in the classroom.

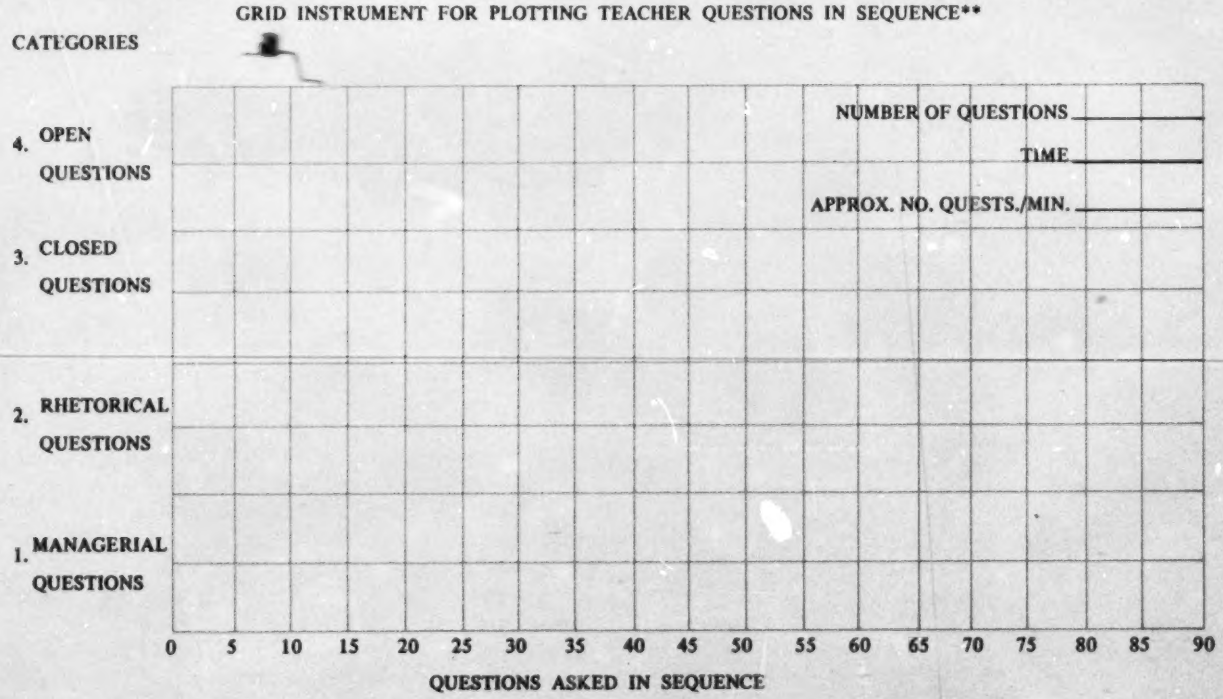
An additional option (which works, too) is to tell your students that you are interested in studying your questions so that you can become a better teacher and that you plan to record the lesson so that you can listen to it later.

When you do record a lesson, don't feel that you must listen to the entire tape. Pick portions to analyze: the beginning, the end, or the place containing the most discussion. It's also a good idea to give yourself a psychological boost by taping the class in which you feel most effective and successful. Once you've become accustomed to analyzing your behavior with this class, then try it with a "problem" class, if you have one, to determine how your questions differ.

Besides making a question count and analyzing the variety, it sometimes helps to see your questioning behavior graphically. You might want to try plotting your questions on a chart such as the one illustrated in Figure 4.

TEACHER _____ LESSON _____ DATE _____ OBSERVER _____

GRID INSTRUMENT FOR PLOTTING TEACHER QUESTIONS IN SEQUENCE**


CATEGORIES
4. OPEN QUESTIONS
3. CLOSED QUESTIONS
2. RHETORICAL QUESTIONS
1. MANAGERIAL QUESTIONS
NUMBER OF QUESTIONS _____
TIME _____
APPROX. NO. QUESTS./MIN. _____
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
QUESTIONS ASKED IN SEQUENCE

NUMBER OF SHIFTS TO OPEN QUESTIONS _____ PERCENTAGE OF QUESTIONS PROCESS ORIENTED _____

** Adapted from material developed by Robert Johnson, 1969.

Figure 4. *Grid for Question Analysis Sequence*

ADDITIONAL SUGGESTIONS TO CONSIDER

Earlier in this booklet you were told to pay attention to the words you used in phrasing questions as well as to make certain your questions were clear and understandable. Here are some additional suggestions for improving your questions.

1) *Check the wording of your questions to determine if you have made them broad or narrow.*

"Would you get an acid or a base if you mixed these compounds?" limits your students to respond "acid" or "base" or "I don't know," while "What do you think might happen if you mixed these compounds?" is a broader question which does not so obviously limit your students' responses.

2) *Try to word your questions to avoid "yes/no" answers, unless that's what you really want.*

"Do you think . . .?" or Should . . .?" questions encourage a "yes" or "no" response. Try instead for a question which might begin "What do you think about . . .?" (although you may get some students who say, "I don't think.").

3) *Avoid repeating student responses.*

If you fall into this common habit, not only are you taking up class time that could be spent in other discussion, you are also encouraging sloppy listening habits on the part of your students. Repeating student responses serves the same function as instant replay on television. It encourages your students to listen to you rather than to each other.

Students soon come to realize that if a response is important, the teacher is going to repeat it. So they listen only to the teacher and save themselves the task of deciding the importance.

If you repeat student responses because some students are timid and don't speak out, develop some nonthreatening techniques for encouraging these students to speak louder. Try something like, "That's an interesting idea. I don't think the whole class heard it though. Would you say it again so everybody can hear?"

If you tend to repeat student responses for reinforcement, consider what Rowe reported (see p. 5) on rate of teacher reinforcement and student exploration and sharing of ideas. Learn to use nonverbal behaviors that tell students their responses have been heard and accepted and develop some verbal responses which you can use for this same purpose.

4) *Develop techniques for getting students to listen to and interact with each other.*

Much questioning behavior consists of a series of teacher and single student dialogues. Try to change this pattern by using remarks such as "What do you think about . . .?" addressed either to the group as a whole or to a specific student or "What can you add to that?" or "How do you feel about that?" or "What might be a different interpretation for that?"

5) *Encourage your students to ask questions.*

You may even have to teach them to ask questions. You might try to develop a variety of discrepant events, problem situations, or question-provoking pictures, photographs, or displays.

6) *Encourage your students to expand on their ideas.*

Avoid what Rowe terms "inquisition" but attempt to get students to elaborate on their responses. Some of this elaboration will result when you learn to make use of Rowe's wait-time 2. If it does not, you can follow this second pause with the use of probing techniques as they are called in teacher education materials developed at Stanford (Blosser, 1973, p. 76). Probing techniques are designed to help a pupil go beyond the original response. They involve such teacher responses as "Explain that further if you can, please" or "How does that relate to . . .?" or "What must we assume here?"

7) *Make certain your questioning techniques and your evaluation techniques are congruent.*

If you ask *Open Questions* in class discussions and then use only *Closed Questions* for purposes of evaluation, you have defeated yourself. Tests and other evaluation methods which do not involve more than the ability to follow directions and to recall and repeat memorized information tell your students that, no matter how you behave in class, what you really value is their ability to produce "right answers."

And that brings us back to where we began in this booklet: to a consideration of whether we are developing students who can, upon demand, produce "right answers" or whether we are encouraging the development in students of the skills they need to possess in order to learn for themselves.

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